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# DEPARTMENTS.

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## SOLUTIONS OF PROBLEMS.

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### ALGEBRA.

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192. Also solved by J. Scheffer, Hagerstown, Md.

193. Proposed by SAUL EPSTEIN, Ph. D., Chicago, Ill.

Professor Goursat states (*Transactions of the American Mathematical Society*, January, 1904, p. 111) that if  $a_1, a_2, \dots, a_n; h_1, h_2, \dots, h_n$  are two sequences, the  $h$ 's being all positive, then  $\sum \frac{a_i^2}{h_i} \geq \frac{(\sum a_i)^2}{\sum h_i}$ . Prove this.

Solution by F. L. GRIFFIN, S. B., and L. E. DICKSON, Ph. D., Chicago, Ill.

For  $n=2$ , the inequality becomes, upon multiplication by the *positive* number  $h_1 h_2 (h_1 + h_2)$  and transposition of terms,  $(a_1 h_2 - a_2 h_1)^2 \geq 0$ . These steps may be reversed, giving a proof for  $n=2$ . For the general case, we proceed by induction, assuming the formula true for  $n=1, 2, \dots, m$ . Then

$$\sum_{i=1}^{m+1} \frac{a_i^2}{h_i} \geq \frac{\left(\sum_{i=1}^m a_i\right)^2}{\sum_{i=1}^m h_i} + \frac{a_{m+1}^2}{h_{m+1}} \geq \frac{\left(\sum_{i=1}^m a_i + a_{m+1}\right)^2}{\sum_{i=1}^m h_i + h_{m+1}} \text{ or } \frac{\left(\sum_{i=1}^{m+1} a_i\right)^2}{\sum_{i=1}^{m+1} h_i}.$$

Also solved by G. B. M. Zerr, Parsons, W. Va., for sequences where

$$a_i = a_{i-1} + m; h_i = h_{i-1} + 1.$$

195. Proposed by W. J. GREENSTREET, A. M., Editor of the *Mathematical Gazette*, Stroud, England.

Prove that when  $n$  is a positive integer,

$$\sum_{r=1}^{r=n} (-1)^r {}_n C_r 2^{n-r} r^2 = n^2 - 2n.$$

Solution by G. W. GREENWOOD, B. A. (Oxon), Professor of Mathematics and Astronomy, McKendree College, Lebanon, Ill.

$$\begin{aligned} (1+x)(1-x)^{-3} &= 1 + 2^1 x + 3^2 x^2 + 4^3 x^3 + \dots (2x-1)^n \\ &= 2^n x^n - c_1 2^{n-1} x^{n-1} + c_2 2^{n-2} x^{n-2} - \dots \end{aligned}$$

Required sum = coefficient of  $x^{n-1}$  in  $(1+x)(1-x)^{-3}(2x-1)^n$ ,

$$i. e., \text{ in } (1+x)(1-x)^{-3}[x^n - c_1 x^{n-1}(1-x) + \dots],$$

$$i. e., \text{ in } (1+x)[x^n(1-x)^{-3} - c_1 x^{n-1}(1-x)^{-2} + \dots],$$

which is  $2c_2 - c_1$  or  $n^2 - 2n$ .

Also solved by G. B. M. Zerr, A. M., Ph. D., Parsons, W. Va.